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Summary of the 1989 Coho Salmon Smolt Trapping Operations on the Lachmach River, British Columbia

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ABSTRACT

Davies, D. L. W. 1991. Summary of the 1989 coho salmon smolt trapping operations on the Lachmach River, British Columbia. Can. Data Rep. Fish. Aquat. Sci. 831: 37 p.

A permanent welded aluminum smolt fence was used to capture smolts at the mouth of the Lachmach River, east of Prince Rupert, British Columbia, between April 27 and June 16, 1989. A total of 21,410 coho smolts were trapped. Of these, 19,482 smolts were coded wire tagged and adipose fin clipped. Totals of 1,176 rainbow trout, 1,592 Dolly Varden, 767 sculpins and four cutthroat trout were also captured.

RÉSUMÉ

Davies, D. L. W. 1991. Summary of the 1989 coho salmon smolt trapping operations on the Lachmach River, British Columbia. Can. Data Rep. Fish. Aquat. Sci. 831: 37 p.

Une barrière permanente en aluminium soudé a été utilisée pour capturer des smolts à l'embouchure de la rivière Lachmach, à l'est de Prince Rupert (Colombie-Britannique), entre le 27 avril et le 16 juin 1989. Un total de 21 410 saumons cohos ont été capturés. De ce nombre, 19 482 smolts ont été étiquetés au moyen d'un fil de fer codé et leur nageoire adipeuse a été coupée. On a également capturé un total de 1 176 truites arc-en-ciel, 1 592 Dolly Varden, 767 chabots et quatre truites fardées.

INTRODUCTION

The Lachmach River Project is part of the Coho Salmon Research Program which was initiated in response to the Canada-U.S. Pacific Salmon Treaty. The Program obtains information on the biology and productivity of coho salmon (Oncorhynchus kisutch) stocks in British Columbia. The Lachmach River Project was set up in the spring of 1987 to obtain information on northern B.C. coho salmon stocks. Data have been collected for two years beginning in 1987 (Table 1) (Finnegan et al. 1990 ; Finnegan 1990).

The Lachmach River is located 23 km. east of Prince Rupert, B.C., at the head of Work Channel (Fig. 1). This report presents data from fence operations, coho smolt trapping and sampling, and coded wire tagging operations conducted in the spring of 1989.

METHODS

The smolt fence used on the Lachmach River in 1989 was described in detail in the 1988 spring data report (Finnegan 1990). Minor changes to the fence in 1989 include the addition of plywood ends in two of the V's and the installation of an additional small mesh Fyke net leading to one of the live boxes. Both these modifications involve attempts to increase juvenile salmonid trapping efficiency. Improvements were also made to the steelhead trout trap for use as a juvenile coho holding pen for coded wire tagging operations.

A temporary smolt fence was installed on the upper Lachmach River immediately downstream of the 5000 m pond (Fig. 2). The design was a standard "W"-shaped fence with two live boxes connected to the fence by 3 meter long lengths of 100 mm PVC pipe (Conlin and Tutty 1979).

Every day at the main fence, fish were sorted by species, enumerated and sampled. Random samples were obtained by rapidly moving a small dipnet through the fish in the trap box and scooping up a netful of fish and putting them in a bucket of water. This was done until approximately 100 fish or about 10% of the total catch was in the bucket. Samples were anaesthetized with 2-phenoxyethanol and measured for fork length and weight. Fork lengths were measured on a smolt board to an accuracy of 0.25 mm Weights were measured on an Ohaus Port-O-Gram balance to an accuracy of 0.05 g. Selection for scale sampling for age analysis was done by dividing smolts into 5 mm size groups from 40 mm to 170 mm and attempting to get 14 scale samples from each group throughout the smolt run. Fin clips, brands and any unusual condition (ie. deformities, injuries, etc.) were recorded. All clipped, branded and unusually large or small fish (whether within the random sample or not) were measured for length and weight and

had scales taken.

At the 5000 m fence, all fish were counted and only fork lengths were taken. All coho smolts were given a lower caudal fin clip.

All mortalities were recorded by species, sexed, and measured for fork length and wet weight. Scales, otoliths and fin rays were taken from some of the dead fish for age analysis.

All coho smolts captured at the main fence were anaesthetized with 2-phenoxyethanol, adipose fin clipped and coded wire tagged with standard tags (Northwest Marine Technologies, Shaw Island, WA. ; Mk II Tagging Unit). Coho smolts were divided into two groups, larger and smaller than 90 mm, and were tagged with different tag codes. Tag codes for large coho were 08/26/48, 08/26/49, 08/26/29 and 08/26/27. The tag code for small coho was 08/26/47. After coded wire tagging ended on June 5, all coho smolts captured were marked with a left maxillary clip.

After each day of tagging, a sample of tagged fish from each size group was held for 24 h to estimate tag retention. Two samples of fish which were tagged on May 24 and May 29 were held for 48 h to see if there was any additional tag loss. All fish that had lost their tags were retagged before release.

Three groups of one hundred smolts were marked and released 50 m upstream of the main fence to assess the fence's capture efficiency. Recaptures of marked fish were recorded at the main fence and the recapture rate was used as an indication of fence efficiency (recognizing that the coho that were not recaptured may have died or stopped their downstream migration). The first group consisted of 47 small and 52 large CWT smolts that were cold branded with a "T" brand on the left dorsal area and released on May 4. The second group consisted of 50 CWT smolts of each size group. The upper lobe of their caudal fins were clipped and they were released on May 14. The third group, released on May 24, consisted of 50 CWT smolts of each size group. They had double upper and lower caudal fin clips and a "P" cold brand.

Adult steelhead were counted through the fence either by dipnetting them and passing them over the top of the fence or by opening a gap in the fence panel and letting them to swim through. On May 6, an adult steelhead upstream trap (constructed out of snow fencing material) was installed in one of the V's of the fence. This confined the steelhead somewhat, making it easier to dipnet them.

Records were kept of cloud cover, precipitation, water temperature and water level. Observations were generally taken twice daily, at 0800 and 2000.

RESULTS

MAIN FENCE

Coho

The Lachmach River smolt fence was in continuous operation for 52 days in 1989. During this period, 21,410 coho smolts were caught (Table 2). Of these, 19,482 smolts were coded wire tagged and 554 were mortalities. There were 1,374 smolts released untagged and unclipped of which 868 were released before the tagging machine was set up, 179 were released after the tagging machine was dismantled and 246 were too small to tag. Large smolts (over 90 mm) were assumed to be age 2.0 and were tagged with a different tag code than small smolts which were assumed to be age 1.0. 76.7% of all the smolts captured and tagged were classed as large smolts. The run peaked on May 16 and a secondary, but more protracted peak, occurred again from May 20 to May 29 (Fig. 4). The peaks in outmigration of coho smolts appear to be initiated by peaks in precipitation (Fig. 5.)

The results of the three fence efficiency tests were somewhat inconsistent. The results of the first test show a trapping efficiency of 74%, but this test was run before the peak in migration. The results of the second test are probably the most accurate and they show a trapping efficiency of 91%. The third test results showed a trapping efficiency of 58%, but marked fish were still being recaptured at the end of the study period.

A total of 10 tagged smolts with adipose clips were captured in the traps moving downstream. The presence of these smolts is unexplained as they were not fence efficiency test smolts as they carried no other marks. In addition to these smolts 13 coho were captured in the traps with no adipose fin, but with no tag. These smolts may have been missing their adipose fin due to a natural deformity or to a physical loss.

Mean tag retention was estimated as 98.4% for large smolts and 98.3% for small smolts over a 24 h. period (Table 3). The 48 h tag retention tests showed no additional tag loss at all. After tag retention estimates are applied to the numbers tagged and released, it is estimated that 4,472 small smolts and 14,795 smolts retained their tags. Table 4 shows the number of tagged smolts released with each tag code.

The overall average fork length of the randomly sampled smolts of all ages was 95.4 mm (SE = 0.18, N = 4,002), the average weight was 7.34 g (SE = 0.046, N = 3,096) (Table 5). The length frequency histogram for all the coho smolts randomly sampled is presented in Figure 6.

A total of 590 smolts had scale samples taken and of these 74

also had fin and otolith samples taken. None of the otolith samples could be analyzed due to the opaqueness and mould around the structures. Of the scale samples, 30 could not be aged, and of the remaining 560, 2 were age 0.0, 135 were age 1.0, 421 were age 2.0 and 2 were age 3.0 (Table 6). Of the 74 fin samples analyzed, 62 (93.8%) of the ages were in agreement with the scale ages, 4 did not agree with the scale ages and in 8 samples only one structure could be aged.

The mean lengths of the age 1.0 and 2.0 fish were 72.9 mm and 107.1 mm respectively. Evaluation of the length-age data showed that the 89-90 mm fork length "cutoff" point used to separate age 1.0 and 2.0 smolts in previous years and in 1989 was too high. A new cutoff point was chosen based on the minimum percentage of misclassifications for both age 1.0 and age 2.0 smolts. This resulted in 85-86mm being chosen as the new cutoff point for age 1.0 and age 2.0 smolts. This resulted in 19% of the age 1.0 smolts being misclassified as age 2.0 and 13% of the age 2.0 smolts being misclassified as age 1.0 smolts.

An estimate of the age composition of the migrating smolts was obtained by first calculating the proportion of each age within 1mm length class. Then each proportion was multiplied by the total number of smolts within each class to get the number of smolts by age in each length class. The numbers were then summed by age over all to obtain the number of smolts by age. These results showed that 13 (0.06%) were age 0.0; 4,368 (20.4%) were age 1.0, 16,999 (79.4%) were age 2.0 and 13 (0.06%) were age 3.0.

Some of the coho recovered at the fence had been previously marked further up the system. This provided a convenient method of verification of the age analysis as the marked fish were of known minimum age. From September to November of 1987, 2,230 left ventral clipped juveniles and 4,352 right ventral clipped juveniles were released in the upper river. Ventral fin clipped smolts recovered at the main fence in 1989 included 123 left ventral clips and 34 right ventral clips. Thus these ventral fin clipped fish would all be at least age 2.0. Age analysis was conducted (without knowledge of the marks) on 155 of these ventral clipped fish and only 8 fish (5.2 %) were incorrectly aged as being one year olds, the remainder, 147 (94.8 %), were aged as 2.0's.

Of the 963 fish marked with a lower caudal fin clip at the 5000 m fence during the 1989 study period, 586 (61%) were noted at the main fence. The peak daily catch of lower caudal clipped fish occurred 8 days after the peak daily release of clipped fish at the 5000 m fence. We marked with a left maxillary clip 179 coho smolts that were captured at the main fence after coded wire tagging ended on June 5.

Of the 554 coho smolt mortalities, 141 were found dead on the fence, 253 were found dead in the traps, 63 were killed during

tagging and 38 smolts were killed during the sampling process. Seven smolts were found inside sculpin's stomachs in one of the traps, 13 smolts were sacrificed for otolith removal, 2 were sacrificed to check for coded wire tag placement and 37 were found dead after the tag retention tests. All the dead smolts were sexed by examining their gonads: 278 were females and 279 were males. The mean lengths of males and females were 91.36 mm and 93.16 mm respectively.

Other Species

Totals of 1,176 rainbow/steelhead trout juveniles (Oncorhynchus mykiss), 1,592 Dolly Varden juveniles (Salvelinus malma), 767 cottids (Cottus sp.), and four cutthroat trout juveniles (Oncorhynchus clarki) were captured moving downstream (Table 7). Tables 8 and 9 show the results of sampling species other than coho at the main fence. Totals of 294 adult steelhead (O. mykiss) were captured moving downstream and 76 adult steelhead were caught moving upstream.

Rainbow trout juveniles increased during the last week of May and peaked at the end of May and the first week in June (Fig. 8). Rainbow trout appeared to be declining by the end of the study on June 16. Dolly Varden sharply increased during the third week in May and peaked a week later. They sharply declined after the first week in June. Cottid numbers were inconsistent throughout the study period, but were highest during the first two weeks of April. Adult steelhead migrating upstream to spawn trickled in throughout the month of May with no obvious peak, while steelhead kelts migrating downstream were captured during the end of May and the beginning of June (Table 7).

5000 M FENCE

The upper fence at 5000 m was continuously fishing for 40 days from April 27 until June 5. Totals of 1,032 coho smolts, 22 Dolly Varden juveniles, 9 rainbow trout juveniles and 1 cutthroat trout juvenile were captured at the 5000 m fence (Table 10). The length frequency of the coho was similar to the length frequency histogram of the coho smolts captured at the main fence (Figure 8). Of the coho juveniles captured at the 5000 m fence, 963 received a lower caudal fin clip and were released.

ENVIRONMENTAL DATA

Environmental data collected included precipitation and water temperature (Fig. 4 and 9). Precipitation was generally low during the study period. The peak was on May 15 with a rainfall of almost 12 mm. The water height data were fairly inaccurate measures of the actual river height. Tne staff gauge was located beside the

fence where water levels were affected by debris on the fence and tides. Water temperatures gradually increased during the study period from 5°C on May 2, to 11°C on June 3 (Fig. 9).

ACKNOWLEDGEMENTS

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Table 1. Historical summary of fish capture and tagging during the spring at the Lachmach River.

year	fence type	coho smolts		other species					
		total	CWT'ed	rbt	D.v.	cottids	stlhd	cutt	coho fry
1987	temp.	1,909	1,790	5	13	97	10		17
1988	perm.	9,983	9,192	103	351	175		4	
1989	perm.	21,410	19,482	1,176	1,592	767	294	4	

Note In 1987, a temporary, wooden smolt fence was used which frequently washed out resulting in an incomplete count of the number of migrating fish.

In 1988, a permanent, aluminum fence was installed, but it is believed that it was not completely fish tight resulting in a low number of migrating fish.

In 1989, the same permanent fence was used and we believe that the numbers of fish captured accurately reflect the true numbers of fish migrating.

CWT'ed = coded wire tagged; temp. = temporary;
perm. = permanent; rbt = rainbow/steelhead trout juvenile;
D.v. = Dolly varden; stlhd = steelhead;
cutt = cutthroat trout juveniles

Table 2. Daily counts of coho smolts at the main fence, Lachmach River, 1989

date	total smolts tagged and released	total smolts untagged	mortalities	total smolts through the fence
Apr. 25	0	1	0	1
Apr .27	0	74	0	74
Apr. 28	0	26	0	26
Apr. 29	0	54	0	54
Apr. 30	0	112	0	112
May 1	0	163	0	163
May 2	0	183	11	194
May 3	0	255	7	262
May 4	285	1	18	304
May 5	303	0	27	330
May 6	166	0	9	175
May 7	436	2	16	454
May 8	273	8	14	295
May 9	393	1	7	401
May 10	176	4	5	185
May 11	229	2	1	232
May 12	326	1	0	327
May 13	578	4	4	586
May 14	821	15	8	844
May 15	1,212	4	11	1,227
May 16	2,653	25	40	2,718
May 17	1,975	31	234[a]	2,240
May 18	177	4	14	195
May 19	227	2	9	238
May 20	681	3	1	685
May 21	714	9	0	723
May 22	769	7	5	781
May 23	915	10	5	930
May 24	910	9	14	933
May 25	659	9	9	677
May 26	1,072	16	6	1,094
May 27	667	1	19	687
May 28	913	19	23	955
May 29	675	20	11	706
May 30	358	7	7	372
May 31	400	1	0	401
June 1	338	6	4	348
June 2	43	2	3	48
June 3	72	2	4	78
June 4	66	18	5	89
June 5	0	84	3	87
June 6	0	21	0	21
June 7	0	23	0	23

Table 2.(cont'd)

date	total smolts tagged and released	total smolts untagged and released	mortalities	total smolts through the fence
June 8	0	17	0	17
June 9	0	11	0	11
June 10	0	16	0	16
June 11	0	19	0	19
June 12	0	18	0	18
June 13	0	31	0	31
June 14	0	21	0	21
June 15	0	1	0	1
June 16	0	1	0	1
Totals	19,482	1,374	554	21,410

[a] Mortalities included 75 smolts found dead on the fence, 34 killed in the tagging process and 41 found dead in the traps.

Table 3. Daily coded wire tagging summary

Date	No. tagged and released[a]			% tag retention		No. with retained tag[b]	
	small	large	total	small	large	small	large
May 4	117	168	285	96	98	112	165
May 5	119	184	303	100	96	119	177
May 6	49	117	166	100	95	49	111
May 7	125	311	436	100	100	125	311
May 8	78	195	273	100	82	78	160
May 9	118	275	393	100	100	118	275
May 10	38	138	176	100	98	38	135
May 11	52	177	229	88	100	46	177
May 12	94	232	326	84	100	79	232
May 13	149	429	578	98	100	146	429
May 14	225	596	821	92	100	207	596
May 15	258	954	1,212	100	100	258	954
May 16	512	2,141	2,653	100	100	512	2,141
May 17	310	1,665	1,975	100	100	310	1,665
May 18	45	132	177	100	98	45	129
May 19	43	184	227	100	100	43	184
May 20	165	516	681	100	98	165	506
May 21	124	590	714	100	98	124	578
May 22	130	639	769	96	100	125	639
May 23	194	721	915	98	100	190	721
May 24	186	724	910	96	96	179	695
May 25	117	542	659	100	100	117	542
May 26	228	844	1,072	100	96	228	810
May 27	151	516	667	100	100	151	516
May 28	257	656	913	100	100	257	656
May 29	209	466	675	100	100	209	466
May 30	131	227	358	100	98	131	222
May 31	151	249	400	100	98	151	244
June 1	90	248	338	100	100	90	248
June 2	14	29	43	100	100	14	29
June 3	30	42	72	100	100	30	42
June 4	26	40	66	100	100	26	40
Total (Mean)	4,535	14,947	19,482	(98.2)	(98.6)	4,453	14,737
					Grand total	19,190	

[a] includes fish that lost their tag and were retagged and released

[b] number tagged and released X percent tag retention

Table 4. Coded wire tagging summary by tag code

tag code	smolt size	total tagged and released	% tag retention	total no. with retained tags
08/26/27	large	2,003	99.4	1,991
08/26/29	large	2,504	98.4	2,464
08/26/47	small	4,535	98.2	4,453
08/26/48	large	5,091	97.6	4,969
08/26/49	large	5,349	98.9	5,290
	Total	19,482	98.3	19,167

Table 5. Summary of Lachmach River coho smolt sampling data, spring, 1989

date	fork length (mm)			wet weight (g)		
	n	mean	SE	n	mean	SE
Apr. 25	1	80.0		0		
Apr. 27	74	85.3	(1.35)	0		
Apr. 28	26	91.1	(1.96)	0		
Apr. 29	54	86.3	(1.30)	0		
Apr. 30	112	88.4	(1.02)	0		
May 1	163	87.8	(0.71)	0		
May 2	100	90.9	(0.98)	0		
May 3	100	90.4	(1.03)	0		
May 4	100	91.0	(0.96)	0		
May 5	100	91.8	(0.89)	100	6.78	(0.020)
May 6	100	92.3	(1.04)	100	6.87	(0.021)
May 7	100	95.0	(1.04)	100	7.60	(0.026)
May 8	100	94.6	(1.01)	100	7.39	(0.023)
May 9	100	94.3	(0.95)	100	7.41	(0.022)
May 10	100	96.1	(0.90)	100	7.80	(0.023)
May 11	100	97.5	(1.09)	100	8.02	(0.026)
May 12	100	93.0	(1.03)	100	6.96	(0.022)
May 13	100	97.0	(1.16)	100	8.02	(0.028)
May 14	100	95.4	(1.04)	100	7.62	(0.023)
May 15	100	96.4	(1.08)	100	7.84	(0.026)
May 16	100	96.9	(1.03)	100	7.96	(0.025)
May 17	100	96.8	(1.08)	100	8.16	(0.026)
May 18	100	97.0	(1.02)	100	8.00	(0.024)
May 19	100	95.5	(1.14)	100	7.72	(0.026)
May 20	100	93.8	(1.03)	100	7.23	(0.021)
May 21	100	98.1	(1.05)	100	8.39	(0.024)
May 22	100	99.3	(0.99)	100	8.59	(0.025)
May 23	100	98.9	(1.06)	100	8.59	(0.027)
May 24	100	97.1	(0.82)	100	7.87	(0.019)
May 25	100	97.3	(1.05)	100	8.14	(0.025)
May 26	100	96.7	(0.95)	100	8.03	(0.023)
May 27	100	96.0	(1.05)	100	7.88	(0.024)
May 28	100	94.7	(0.93)	100	7.73	(0.021)
May 29	100	94.1	(1.09)	100	7.53	(0.025)
May 30	100	92.5	(1.17)	100	7.30	(0.027)
May 31	100	88.5	(1.10)	100	6.41	(0.023)
June 1	100	95.5	(1.24)	100	7.80	(0.030)
June 2	48	95.0	(1.68)	48	8.01	(0.037)
June 3	74	90.6	(1.27)	74	6.90	(0.026)
June 4	87	86.6	(1.80)	87	6.43	(0.036)
June 5	84	82.5	(1.80)	84	5.70	(0.035)
June 6	21	78.9	(3.21)	0		

Table 5. (cont'd)

date	fork length (mm)			wet weight (g)		
	n	mean	SE	n	mean	SE
June 7	23	77.4	(3.78)	0		
June 8	17	75.7	(3.25)	0		
June 9	11	78.8	(4.14)	0		
June 10	16	77.0	(3.09)	0		
June 11	19	71.3	(1.81)	0		
June 12	18	70.9	(2.48)	0		
June 13	31	69.8	(1.83)	0		
June 14	21	69.1	(2.34)	0		
June 15	1	66.0		0		
June 16	1	67.0		0		
Totals	4,002			3,093		
Means		95.4			7.34	
SE			(0.18)			(0.046)

Table 6. Summary of data collected from coho smolts for age analysis, Lachmach River,1989

age	fork length (mm)				wet weight (g)		
	n	%	mean	SE	n	mean	SE
0.0	2	0.4	52.0	(0.71)	2	1.65	(0.11)
1.0	135	24.1	72.9	(0.81)	135	3.75	(0.12)
2.0	421	75.1	107.1	(0.66)	414	11.10	(0.22)
3.0	2	0.4	126.0	(4.24)	2	19.63	(2.07)
Total	560[a]				553		
(mean)		100.0	(98.7)	(0.83)		(9.31)	(0.22)

[a] 15 samples could not be aged

Table 7. Daily captures of other species at the main fence, spring, 1989

date	rainbow trout	dolly varden	Cottus sp.	cutthroat trout	adult steelhead upstream	adult steelhead downstream
Apr 27	8	1	1	0	0	0
Apr 28	1	3	31	0	0	0
Apr 29	0	109	25	0	0	0
Apr 30	4	3	17	0	0	0
May 1	0	7	25	0	0	0
May 2	3	23	88	2	12	0
May 3	8	13	57	0	0	0
May 4	2	6	22	0	1	0
May 5	0	5	35	0	0	0
May 6	0	3	32	0	8	0
May 7	1	5	21	0	4	0
May 8	2	6	32	0	1	0
May 9	1	15	26	0	6	0
May 10	1	6	23	0	0	0
May 11	0	5	19	0	1	0
May 12	2	11	17	0	3	0
May 13	2	6	7	0	4	0
May 14	0	9	22	0	1	1
May 15	3	10	26	0	1	0
May 16	2	77	22	1	0	0
May 17	1	23	19	0	0	0
May 18	1	12	3	0	0	0
May 19	0	9	5	0	2	0
May 20	9	14	4	0	0	0
May 21	0	37	9	0	8	0
May 22	3	40	9	0	10	0
May 23	1	45	0	0	4	0
May 24	11	58	7	0	5	0
May 25	9	60	3	0	0	0
May 26	17	91	4	0	0	0
May 27	18	65	5	0	1	0
May 28	18	76	14	0	0	40
May 29	41	126	11	0	3	37
May 30	47	93	18	0	0	1
May 31	67	116	11	0	0	3
June 1	109	131	19	0	0	21
June 2	50	50	16	0	0	35
June 3	63	25	9	0	1	38
June 4	117	70	8	0	0	15
June 5	130	72	16	0	0	0
June 6	31	4	3	0	0	0
June 7	38	6	6	0	0	0
June 8	42	6	2	0	0	0
June 9	64	7	1	0	0	0
June 10	39	8	5	0	0	0

Table 7. (cont'd)

date	rainbow trout	dolly varden	Cottus sp.	cutthroat trout	adult steelhead upstream	adult steelhead downstream
June 11	36	4	0	0	0	0
June 12	54	3	1	0	0	0
June 13	73	7	2	0	0	103
June 14	36	8	3	0	0	0
June 15	7	2	3	0	0	0
June 16	4	1	3	1	0	0
Total	1,176	1,592	767	4	76	294

Table 8. Fork length sample sizes and summaries from species other than coho that were caught at the main fence, Lachmach River, 1989

date	rainbow trout		dolly varden		*Cottus* sp.		cutthroat trout	
	n	f.l.(SE) (mm)	n	f.l.(SE) (mm)	n	f.l.(SE) (mm)	n	f.l. SE (mm)
Apr 27	8	134.1 (5.27)	1	117.0	1	53.0	0	
Apr 28	1	107.0	0		0		0	
Apr 29	0		0		0		0	
Apr 30	4	104.0(13.9)	3	131.7(20.13)	0		0	
May 1	0		7	157.4(15.53)	0		0	
May 2	3	127.3 (1.75)	23	161.6(14.34)	88	109.6 (2.65)	2	162.0 (0.35)
May 3	8	125.1(10.18)	13	137.2(13.06)	57	108.5 (2.87)	0	
May 4	2	105.5(11.67)	6	108.2 (3.62)	22	117.1 (6.42)	0	
May 5	1	84.0	6	167.0(24.00)	44	105.7 (4.60)	0	
May 6	0		3	126.7 (6.41)	32	113.6 (3.44)	0	
May 7	1	150.0	5	214.0(29.65)	21	103.7(5.50)	0	
May 8	2	141.0 (2.12)	6	127.8(15.84)	33	120.6(4.95)	0	
May 9	1	131.0	15	143.6(12.50)	29	105.1(4.92)	0	
May 10	1	105.0	6	162.5(23.96)	25	98.5(3.88)	0	
May 11	0		4	107.7 (2.50)	20	111.6(5.86)	0	
May 12	2	107.0 (5.66)	11	174.4(30.27)	17	90.9(5.97)	0	
May 13	2	145.0 (6.36)	8	143.6(13.95)	7	111.9(9.79)	0	
May 14	0		9	127.7(12.67)	23	100.9(5.69)	0	
May 15	4	139.2 (8.85)	10	115.7 (2.05)	26	113.1(4.55)	0	
May 16	2	159.0 (7.78)	77	156.3 (5.85)	22	108.1(5.12)	0	
May 17	1	123.0	23	128.1 (2.54)	19	96.5(5.48)	0	
May 18	1	102.0	12	121.2 (4.33)	3	115.3(3.29)	1	318.0
May 19	0		10	112.5 (5.00)	5	104.0(9.21)	0	
May 20	9	151.4 (7.57)	14	170.8(11.97)	4	114.2(2.20)	0	
May 21	0		37	144.8 (5.13)	9	112.7(4.50)	0	
May 22	3	165.7 (7.56)	40	150.2 (6.40)	9	119.0(4.83)	0	
May 23	1	140.0	46	139.5 (5.42)	0		0	
May 24	13	146.5 (9.32)	62	137.1 (3.58)	7	111.9(6.80)	0	
May 25	9	145.1 (11.60)	60	129.7 (1.48)	3	80.7(15.90)	0	
May 26	17	141.2 (7.69)	91	133.6 (2.07)	4	104.2(15.15)	0	
May 27	18	146.3 (6.67)	67	130.0 (2.72)	5	110.2(9.21)	0	
May 28	18	135.9 (8.06)	76	132.7 (2.28)	14	90.8(7.67)	0	
May 29	41	130.6 (4.61)	126	132.1 (1.58)	11	102.5(5.25)	0	
May 30	47	125.3 (4.03)	93	127.4 (1.18)	18	103.6(7.02)	0	
May 31	69	141.1 (3.35)	116	132.6 (1.84)	11	99.8(5.16)	0	
June 1	109	146.0 (2.67)	132	128.6 (1.10)	19	100.2(4.36)	0	
June 2	50	153.8 (4.19)	50	130.1 (2.02)	16	114.3(7.12)	0	
June 3	65	146.7 (3.36)	26	124.5 (3.47)	9	118.4(7.67)	0	
June 4	118	138.6 (2.42)	71	130.4 (1.60)	9	110.4(8.50)	0	
June 5	0		0		0		0	
June 6	31	146.9 (4.67)	4	138.7 (1.65)	3	90.7(14.08)	0	
June 7	38	147.0 (4.17)	6	124.7 (8.20)	6	99.7(12.53)	0	
June 8	42	150.7 (3.84)	6	131.5 (4.45)	2	109.5(4.60)	0	

Table 8. (cont'd)

date	rainbow trout		dolly varden		*Cottus* sp.		cutthroat trout	
	n	f.l.(SE) (mm)	n	f.l.(SE) (mm)	n	f.l.(SE) (mm)	n	f.l.(SE) (mm)
June 9	64	145.2 (3.07)	7	133.7 (4.80)	1	141.0	0	
June 10	39	140.8 (4.87)	8	123.2 (5.06)	5	97.2(13.24)	0	
June 11	36	123.9 (4.92)	4	115.2 (9.45)	0		0	
June 12	54	123.9 (3.03)	3	129.7 (3.64)	1	86.0	0	
June 13	73	119.6 (2.83)	7	111.9 (5.90)	2	84.5(16.62)	0	
June 14	36	113.3 (3.90)	8	111.7 (4.88)	3	118.7(3.98)	0	
June 15	7	104.4 (4.31)	2	161.0(31.11)	3	104.3(10.04)	0	
June 16	4	124.5 (7.05)	1	91.0	3	97.7(10.80)	1	143.0
Total	1,056		1,417		636		4	
Mean (SE)		130.8 (0.82)		141.2 (1.14)		102.9 (1.01)		196.0(22.00)

Table 9. Wet weight sample sizes, means and standard errors from species other than coho that were caught at the main fence, Lachmach River,1989.

date	rainbow trout		dolly varden		*Cottus* sp.	
	n	mean (SE) (g)	n	mean (SE) (g)	n	mean (SE) (g)
May 18	1	9.3	12	16.1 (1.74)	3	20.7 (3.35)
May 20	9	31.6 (4.71)	14	44.8 (8.51)	4	17.2 (1.07)
May 21	0		37	26.3 (3.10)	9	16.7 (2.00)
May 22	3	39.1 (5.74)	40	31.7 (4.47)	9	20.8 (2.91)
May 23	1	23.9	45	20.6 (1.44)	0	
May 24	11	28.0 (5.12)	59	23.3 (2.16)	7	14.0 (2.09)
May 25	9	30.4 (4.94)	60	18.0 (0.66)	3	6.8 (3.82)
May 26	17	27.1 (3.57)	91	20.1 (1.07)	4	14.6 (6.00)
May 27	18	29.4 (3.28)	65	19.4 (1.71)	5	14.2 (3.43)
May 28	18	26.2 (3.95)	75	20.0 (1.27)	14	10.3 (2.57)
May 29	41	22.2 (1.95)	126	19.6 (0.78)	11	12.4 (2.25)
May 30	47	18.9 (1.68)	93	17.2 (0.51)	17	17.2 (4.40)
May 31	67	25.7 (1.54)	116	19.7 (1.02)	11	10.7 (1.67)
June 1	52	31.7 (1.58)	53	18.1 (0.84)	19	16.7 (4.14)
June 2	50	33.4 (2.05)	50	18.2 (0.89)	16	23.2 (6.80)
June 3	63	29.2 (1.70)	25	16.7 (1.10)	9	21.8 (5.88)
June 4	53	23.5 (1.66)	54	18.6 (0.76)	8	14.9 (3.63)
Total	460		1,015		149	
Mean (SE)		27.0 (0.65)		20.4 (0.40)		16.18 (1.25)

Table 10. Sample sizes and length summaries of the fish caught at the 5000 m fence, Lachmach River, 1989

date	coho		rainbow trout		dolly varden		cutthroat trout	
	n	mean (SE) length (mm)	n	mean (SE) length (mm)	n	mean (SE) length (mm)	n	mean length (mm)
Apr 27	7	86.4 (2.81)	0		0		0	
Apr 28	12	86.9 (3.09)	0		1	128.0	0	
Apr 30	26	85.3 (1.33)	0		3	97.0 (9.01)	0	
May 1	25	94.0 (0.26)	1	92.0	1	114.0	1	141.0
May 2	8	88.9 (2.45)	0		1	115.0	0	
May 3	30	90.2 (1.28)	0		3	83.0 (5.66)	0	
May 4	6	86.5 (2.45)	0		0		0	
May 5	6	99.7 (3.07)	0		0		0	
May 6	42	93.2 (1.46)	2	99.5 (2.47)	0		0	
May 7	33	91.8 (1.71)	0		0		0	
May 8	54	91.1 (1.08)	0		2	127.0 (6.72)	0	
May 9	2	94.5 (0.35)	0		0		0	
May 11	1	114.0	0		0		0	
May 13	0		0		1	115.0	0	
May 14	0		0		1	100.0	0	
May 15	148	94.1 (0.69)	0		1	119.0	0	
May 16	427	97.5 (0.45)	0		0		0	
May 17	5	92.5 (1.73)	0		0		0	
May 20	1	95.0	0		0		0	
May 21	1	93.0	0		0		0	
May 22	3	104.0 (3.74)	0		0		0	
May 23	12	91.8 (2.03)	0		0		0	
May 24	50	93.0 (1.15)	2	96.5 (3.18)	0		0	
May 26	21	92.5 (1.50)	0		1	123.0	0	
May 27	16	89.2 (2.37)	0		0		0	
May 28	43	88.7 (1.88)	0		1	124.0	0	
May 29	24	88.6 (2.51)	1	109.0	1	141.0	0	
May 30	12	69.2 (4.85)	1	88.0	1	117.0	0	
May 31	5	76.2 (7.38)	0		0		0	
June 1	3	87.3(10.80)	0		0		0	
June 2	4	81.2 (7.40)	1	80.0	1	120.0	0	
June 3	3	67.7 (7.56)	1	90.0	0		0	
June 4	2	85.0 (7.78)	0		3	93.7 (16.63)	0	
Total	1,032		9		22		1	
Mean (SE)		93.7 (0.33)		94.6 (2.75)		108.7 (4.47)		141.0

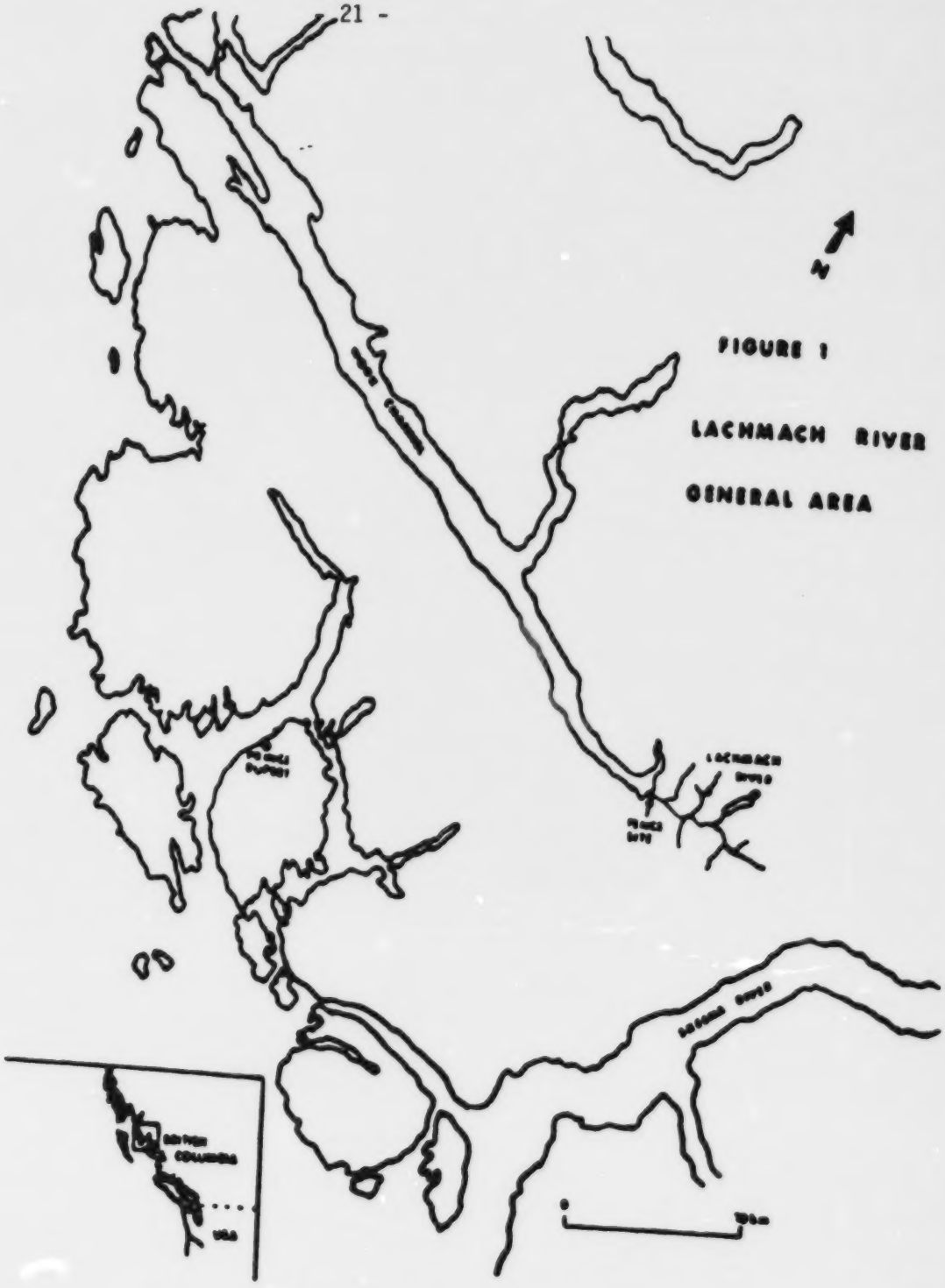


FIGURE 1

LACHMACH RIVER

GENERAL AREA

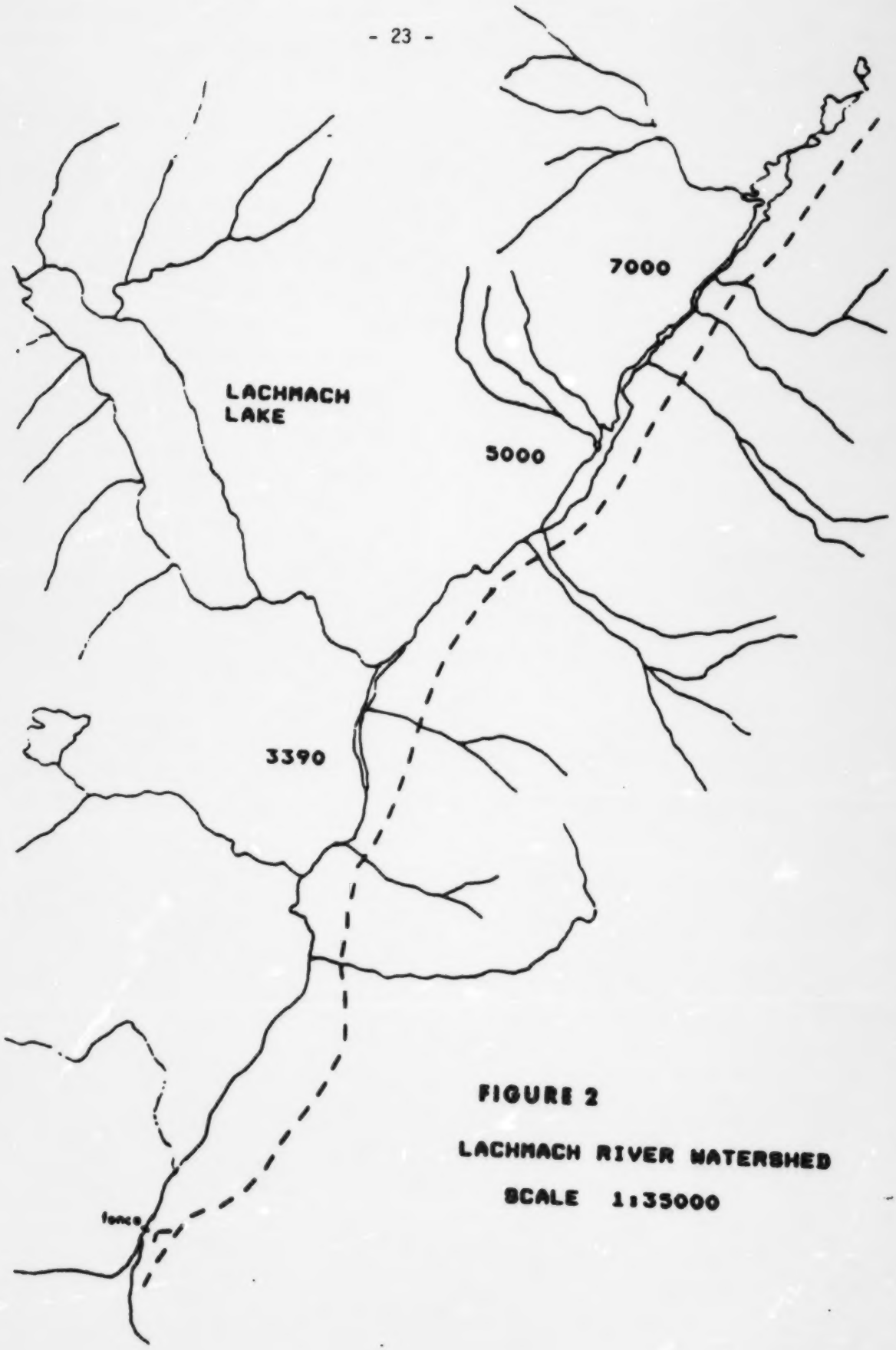


FIGURE 2

LACHMACH RIVER WATERSHED

SCALE 1:35000

Figure 3 Daily captures of coho smolts at the main fence, Lachmach River,1989

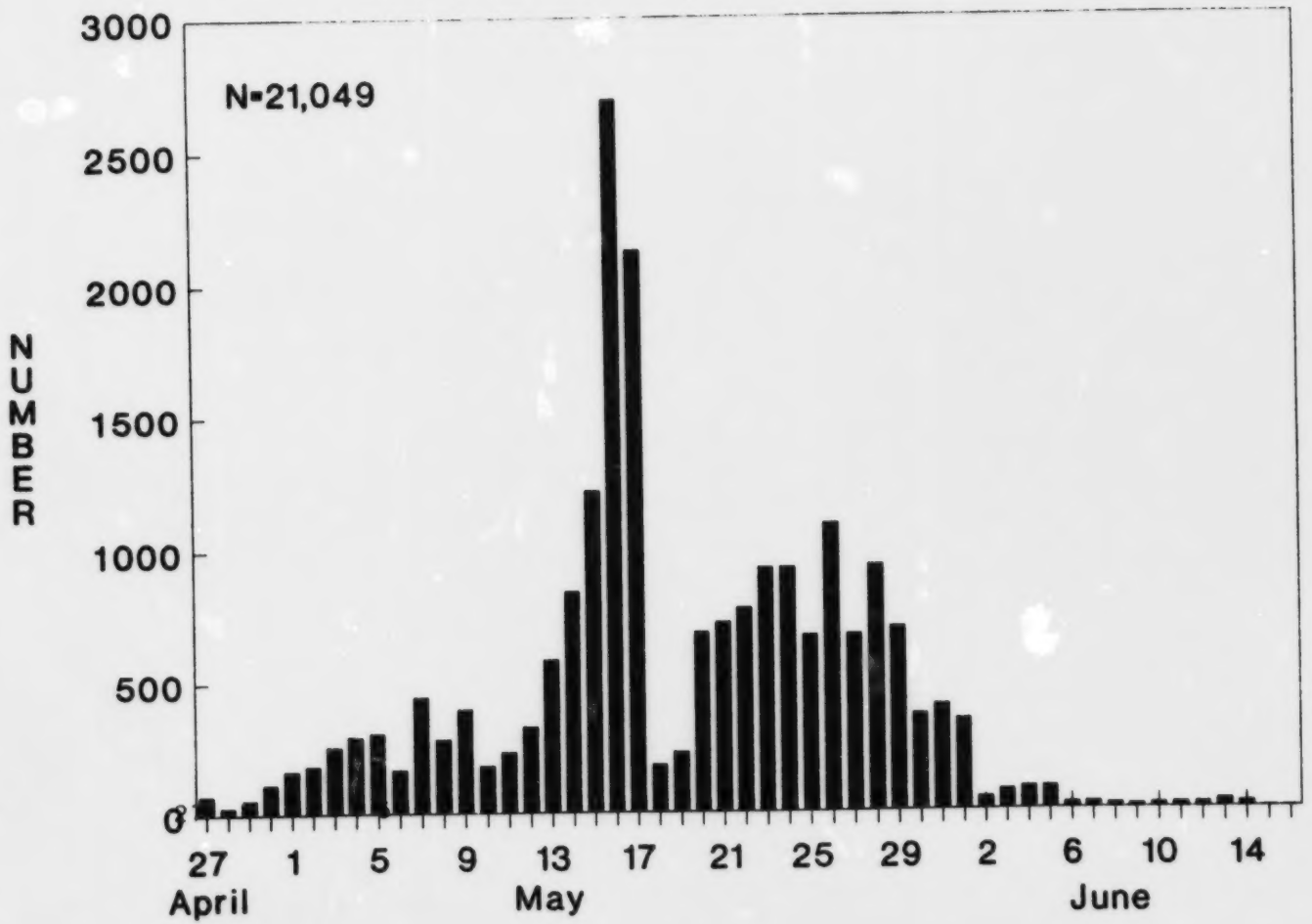


Figure 4. Maximum daily precipitation at the main fence, Lachmach River, 1989

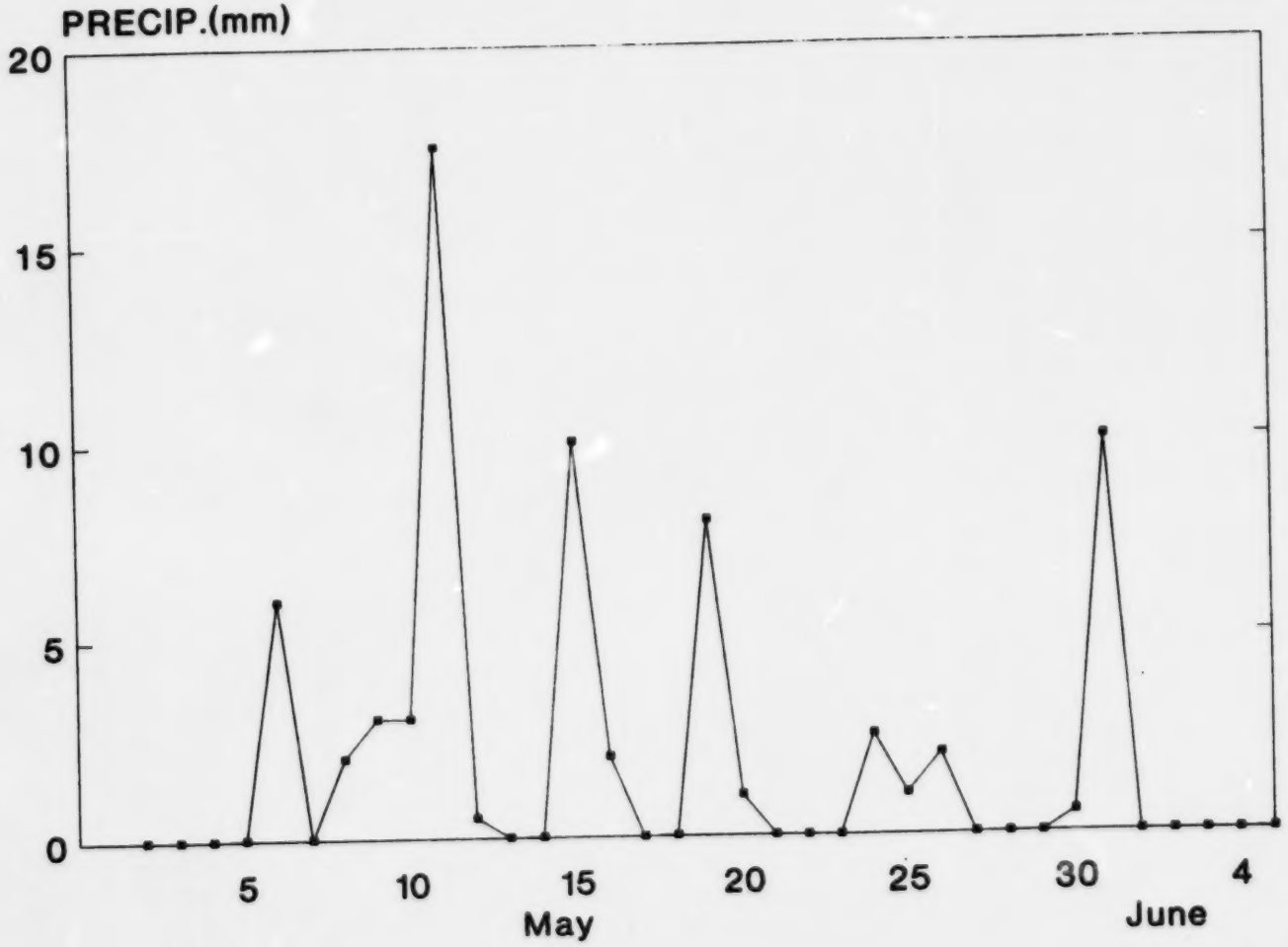
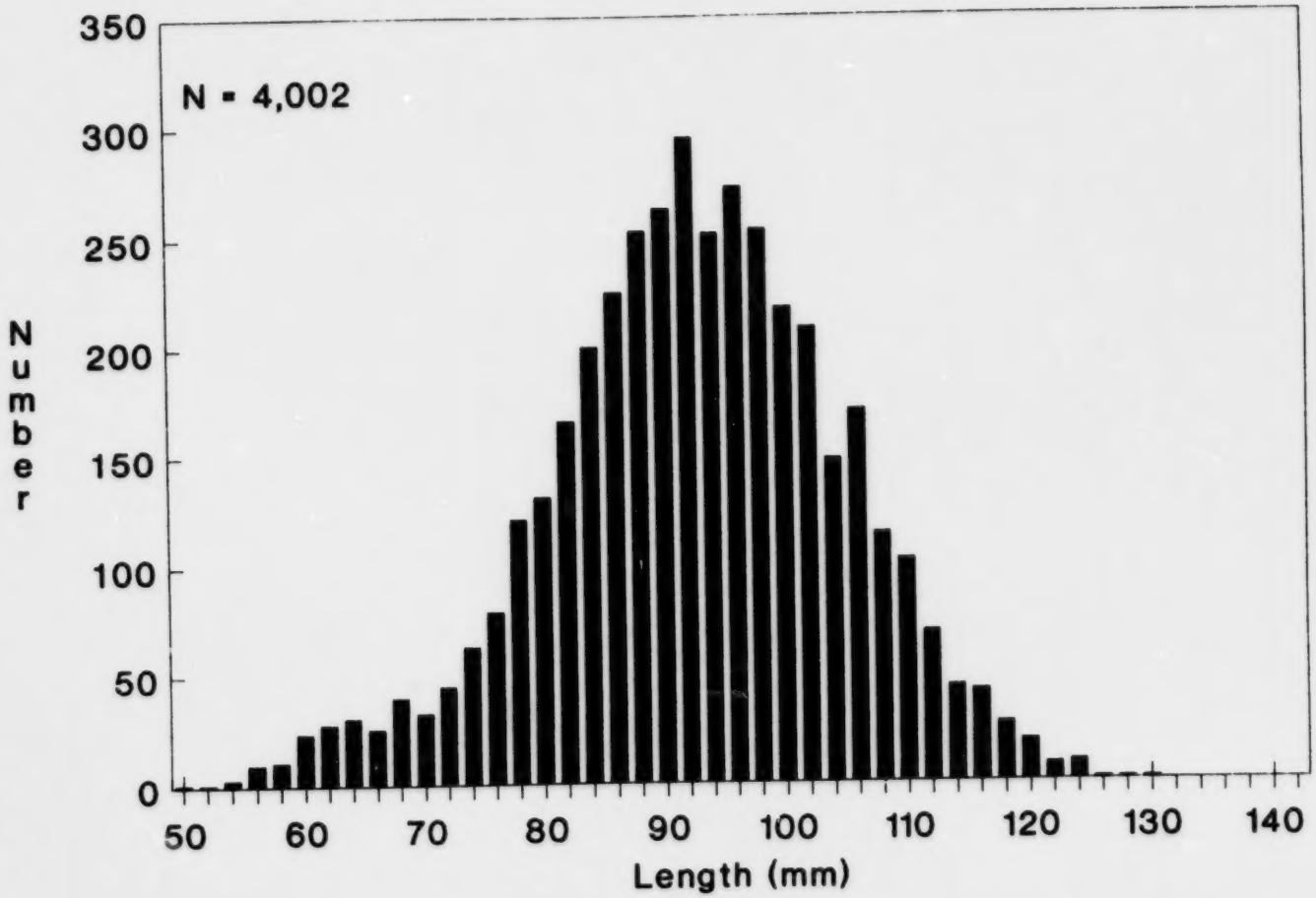


Figure 5. Length frequencies of coho smolts from the main fence, Lachmach River, 1989



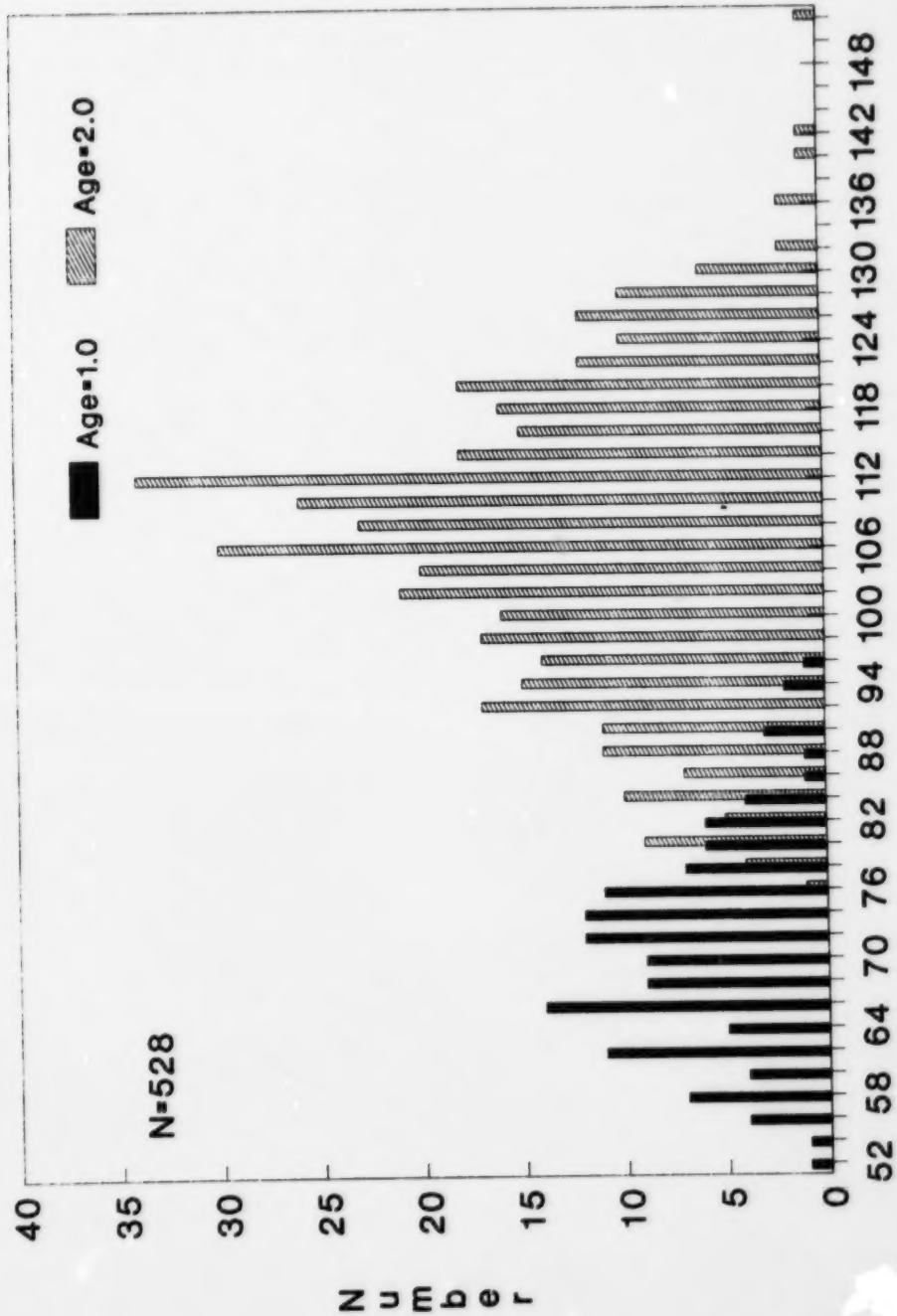


Figure 6. Length frequencies of coho smolts by age from the main fence, Lachmach River, 1989

Figure 7. Weekly captures of species other than coho at the main fence, Lachmach River, 1989

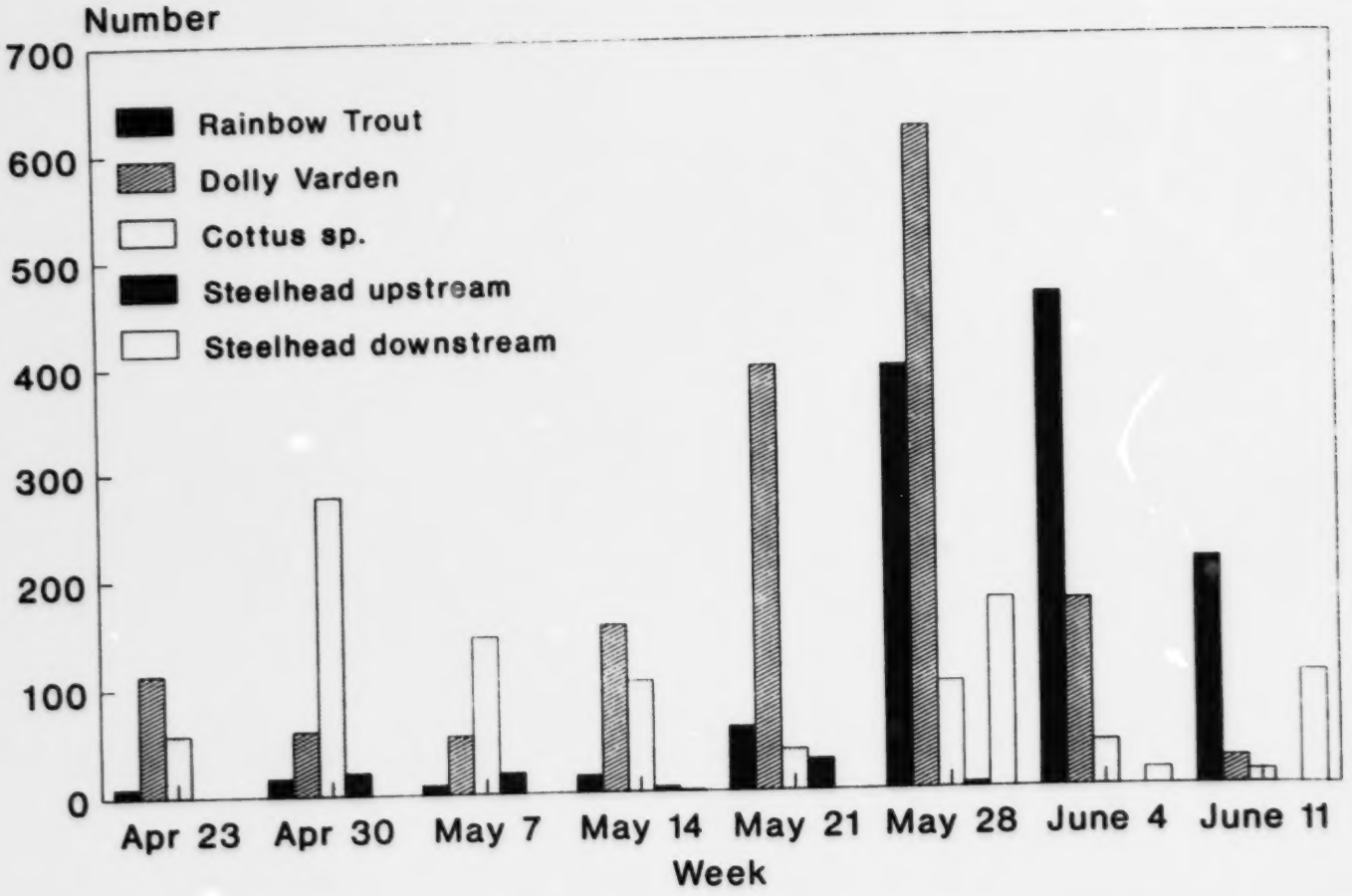


Figure 8 Length frequencies of coho smolts from the 5000 m fence, Lachmach River, 1989

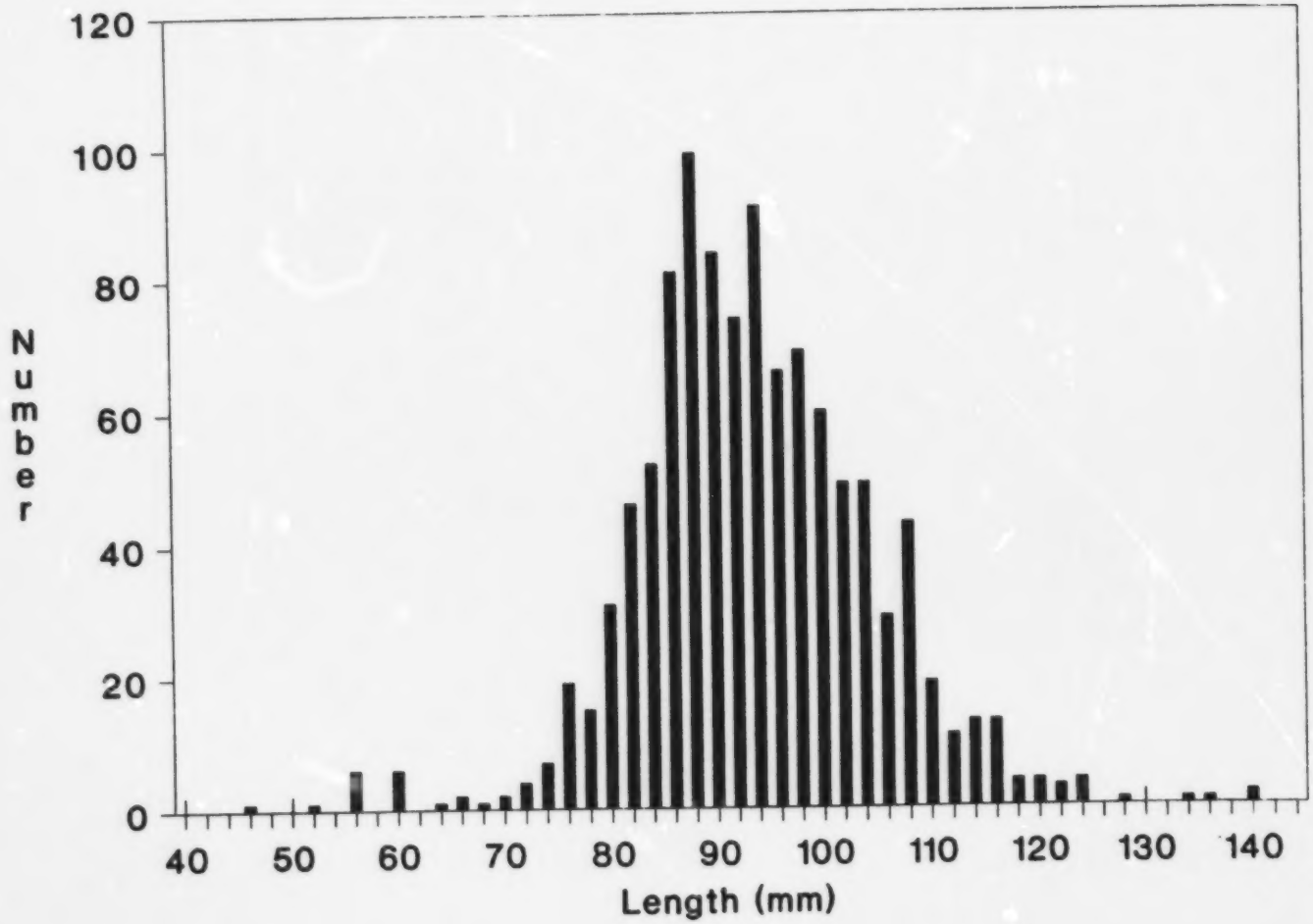


Figure 9. Daily water temperatures at the main fence, Lachmach River, 1989